Original Article

DOI: 10.7860/JCDR/2026/80618.23363

Internal Medicine Section

Clinical Profile and Outcomes of Malabar Pit Viper (*Trimeresurus malabaricus*) Envenomation: A Retrospective Observational Study from Kerala, Southern India

DEVAPRIYA REJEEV[1], SREELAKSHMI MOHANACHANDRAN[2], ANEESH BASHEER[3]

ABSTRACT

Introduction: Kerala reports a high incidence of snakebites, with about 37 venomous species. Besides the "Big 4" (Cobra, Krait, Russell's Viper, and Saw-scaled Viper), the Malabar Pit Viper (MPV) is also notable, especially in the Western Ghats. MPV is endemic to high-altitude, forested regions and presents with local symptoms like pain and swelling, along with haematotoxicity.

Aim: To evaluate the clinical characteristics, management, and outcomes of patients with confirmed MPV envenomation at a tertiary centre in Wayanad, Kerala, India.

Materials and Methods: The present retrospective observational study was conducted using data from patients admitted over a two-year period, from January 2021 to December 2022. Hospital records were reviewed to identify confirmed cases of MPV envenomation. Cases were included based on either the physical presentation or photograph of the snake brought by the patient, or a clinical diagnosis confirmed by the treating physician. Data collected included patient demographics, anatomical site of the bite, local and systemic manifestations, results of the 20-minute Whole Blood Clotting Test (WBCT), administration of antivenom, and any complications encountered. All data were anonymised and entered into Epicollect5 for collection and management. Statistical analysis was performed using R software.

Results: Of the 61 patients admitted with snakebites, 20 (32.8%) were confirmed cases of MPV envenomation. The majority of bites occurred on the upper limbs (n=14, 70%). Local pain and swelling were reported in 13 patients (65%). A prolonged 20-minute WBCT was observed in eight patients (40%). Despite limited evidence of efficacy against MPV venom, 15 patients (75%) received Anti-Snake Venom (ASV). Complications were noted in two patients (10%): one developed cellulitis and the other had an adverse reaction to ASV. All patients recovered fully without any long-term sequelae.

Conclusion: MPV (*Trimeresurus malabaricus*) bites are a notable cause of envenomation in Wayanad, Kerala, typically causing local symptoms with generally good patient outcomes. The routine use of Indian polyvalent ASV is of limited benefit and carries risk of adverse reactions. Developing region and species-specific antivenoms could improve treatment efficacy, reduce risks, and optimise clinical management.

Keywords: Antivenins, Blood coagulation tests, Hemostasis disorders

INTRODUCTION

Snakebite envenomation remains a significant public health concern in India, particularly in rural and forested regions. Among Indian states, Kerala reports a high incidence of snakebites, attributed to its tropical climate, dense vegetation, and proximity of human settlements to forested areas. The state is home to approximately 37 species of venomous snakes, including the well-known "Big Four": Indian Cobra (*Naja naja*), Common Krait (*Bungarus caeruleus*), Russell's Viper (*Daboia russelii*), and Saw-scaled Viper (*Echis carinatus*) [1]. In addition to these, other medically important species frequently encountered in Kerala include the Hump-nosed Pit Viper (*Hypnale hypnale*), MPV (*Trimeresurus malabaricus*), Bamboo Pit Viper (*Trimeresurus gramineus*), and Banded Krait (*Bungarus fasciatus*) [2].

The MPV (*Trimeresurus malabaricus*) is an arboreal, haemotoxic species endemic to the Western Ghats, a biodiversity hotspot along the southwestern coast of India [3]. This snake species is primarily found in high-altitude regions with dense forest cover and is often encountered near water sources such as streams and rivers. It is characterised by a triangular head broader than the neck, the presence of heat-sensing loreal pits, and a distinctive dorsal pattern with various colour morphs including green, brown, and yellow. They mainly prey on tree-dwelling frog species and are often found near water bodies such as ponds, streams, and water holes, where gliding frogs gather to mate during the monsoon season. The cryptic colouration and largely nocturnal nature of the MPV contribute to frequent accidental encounters with humans, particularly among agricultural workers, forest dwellers, and trekkers [4].

Envenomation by the MPV typically results in significant local effects such as pain, swelling, and tissue inflammation. Systemic manifestations may include haematotoxicity, prolonged clotting time, and in rare cases, mild renal impairment [5]. MPV venom contains total 97 proteins that belong to 16 protein families such as L-amino acid oxidase, metalloprotease, serine protease, phospholipase A2, 5′-nucleotidase, C-type lectins/snaclecs and disintegrin [6]. However, the clinical profile of bites from this species can vary, and the absence of epidemiological and clinical data complicates the development of standardised management protocols.. The Indian polyvalent ASV, currently the mainstay of treatment for venomous bites in India, is produced using venom from the Big Four species and lacks efficacy against pit viper venom, including that of the MPV [7]. This raises concern over the use of ASV in managing pit viper bites, given the potential for adverse reactions and its limited therapeutic benefit in such cases.

Existing literature on MPV envenomation is sparse, consisting primarily of isolated case reports or small case series [8]. While some studies have described the clinical manifestations and laboratory abnormalities associated with envenomation by closely related species such as the hump-nosed pit viper or bamboo pit viper, comprehensive studies specifically focusing on *Trimeresurus malabaricus* are notably lacking [3,9]. Moreover, there is a scarcity of data from the Western Ghats region, where this species is most commonly encountered [10]. This geographic and taxonomic gap in the literature limits the understanding of the natural history, clinical outcomes, and optimal management strategies for bites caused by the MPV.

The paucity of species-specific data has several implications. Clinicians in endemic areas may misidentify or under-recognise envenomation by *T. malabaricus*, leading to either under-treatment or inappropriate use of ASV. Inappropriate administration of ASV not only increases the risk of hypersensitivity reactions but also adds to the economic burden on healthcare systems. Furthermore, the absence of targeted diagnostic tools and treatment protocols impedes effective triage and management of patients presenting with pit viper bites. In light of these challenges, the present study was undertaken to evaluate the clinical characteristics, management approaches, and outcomes of patients with confirmed MPV envenomation at a tertiary care centre in Wayanad, Kerala, India, an area within the Western Ghats with high snakebite incidence.

MATERIALS AND METHODS

The present retrospective observational study was conducted using data from patients admitted over a 24-month period from January 2021 to December 2022 at Dr. Moopen's Medical College, a tertiary care centre located in Wayanad, a hilly district in North Kerala along the Western Ghats. The clinical data used in this study were retrospectively obtained from patient records dated January 2021 to December 2022. The study was conceptualised, planned, and executed, including data extraction, verification, analysis, and interpretation, between January 2023 and June 2023. As this was a record-based retrospective study using fully anonymised data, a formal sample size calculation was not applicable. Ethical clearance was obtained from the Institutional Ethics Committee of Dr. Moopen's Medical College (Approval Number: IEC/DMMC/JUNE/2024-01). As this was a retrospective study based on anonymised data, the requirement for individual informed consent was waived by the ethics committee.

Inclusion criteria:

- Patients admitted with a confirmed diagnosis of MPV (*Trimeresurus malabaricus*) envenomation between January 2021 and December 2022.
- Confirmation based on:
  - Snake brought to the hospital and identified by clinicians.
  - Clear photograph of the snake presented by patient or relatives.
  - Documented identification by the attending physician, verified through follow-up to assess basis for diagnosis.

Exclusion criteria:

- Cases where the species of the snake could not be confirmed by visual evidence or documented clinical identification.
- Incomplete medical records lacking key clinical and outcome data.

Out of 61 total snakebite admissions during the study period, 20 patients met the inclusion criteria and were included in the final analysis. A total of 41 cases were excluded due to unconfirmed species identification or incomplete records.

Study Procedure

Case records were retrieved from the hospital information management system using keywords including snakebite, pit viper, MPV, envenomation, and snake envenomation. Eligible records were screened in detail to confirm the diagnosis of MPV envenomation based on the inclusion criteria.

The following data were extracted from each record:

- Demographics: Age, sex
- Clinical presentation: Bite site, presence of fang marks, local signs (pain, swelling, cellulitis), systemic manifestations
- Laboratory findings: Basic hematology, 20-minute WBCT
- Treatment details: Use of Indian polyvalent ASV, total ASV dose, occurrence of adverse reactions
- Outcomes: Length of hospital stay, complications, and recovery status

STATISTICAL ANALYSIS

Data collected from confirmed cases of MPV envenomation were entered into Epicollect 5 and analysed using R statistical software. Continuous variables such as duration of hospital stay were summarised using means and Standard Deviations (SD). Categorical variables like bite location, presence of local symptoms, WBCT results, and ASV administration were expressed as frequencies and percentages. The analysis was purely descriptive due to the retrospective nature and small sample size of the study. No inferential statistical tests were applied. The findings provide an overview of clinical presentations and outcomes, serving as a basis for further prospective studies.

RESULTS

During the period between January 2021 and December 2022, we identified 61 admitted cases of snake bite. Of these, there were 20 cases of MPV bites. The mean age of the victims was 48±14 years. The other demographic characteristics of the patients are summarised in [Table/Fig-1]. Of the 20 confirmed MPV snakebite cases, most were identified through visual confirmation. Common symptoms included fang marks in 17 (85%), upper limb bites in 14 (70%), local swelling in 13 (65%), and severe pain in 13 (65%). Local swelling and severe pain were managed with Non-steroidal Anti-inflammatory Drugs analgesic diclofenac, magnesium sulfate dressing to reduce the swelling, and supportive treatment, while features of cellulitis were treated with antibiotic Amoxycilin Clavulanic acid. Although 8 (40%) had a prolonged 20-minute WBCT, none

Parameters	Values
Mean age in years±SD	**48±14**
Gender	
Male (%)	13 (65)
Female (%)	7 (35)
Mean time to seek medical care in hours ±SD	122±53
Location of bite	
Hand (%)	14 (70)
Foot (%)	6 (30)
Activity at the time of bite	
Agricultural work (%)	8 (40)
Other (%)	12 (60)
Time of bite	
Day (%)	9 (45)
Night (%)	11 (55)
Bleeding manifestations (%)	None
Need for blood products (%)	None

[Table/Fig-1]: Major demographic and clinical characteristics of MPV bite victims (n=20).

showed bleeding, and 15 (75%) received ASV. The average hospital stay was 3.6 days.

The indications for ASV administration are summarised in [Table/Fig-2]. All patients recovered without any residual deficits. Only two (10%) patients developed complications in the form of cellulitis and reaction to ASV, respectively.

Indication for ASV	Number of patients who received ASV	Mean total dose as vials used per patient (SD)
Prolonged 20-WBCT	8	10 (4)
Progressive local reaction	6	10 (3)
Transient hypotension not responding to fluids	3	5 (2)

[Table/Fig-2]: Average dose of Anti Snake Venom (ASV) administered to patients (n=15).
Total number of patients exceeds 15 as indications were overlapping in some of them.
SD: Standard deviation

DISCUSSION

The present study examined the clinical characteristics and outcomes of envenomation from the (MPV, *Trimeresurus malabaricus*). Patients included had bites confirmed either by direct visual identification of the snake (dead or alive) or through high-quality photographic evidence. Most bites involved the upper limbs, and all patients recovered fully, consistent with the generally non-lethal nature of MPV envenomation [1,5].

MPV bites are often underreported in India, partly due to the perception that its venom is non-lethal and because it inhabits limited geographical regions such as Maharashtra, Goa, Karnataka, and northern Kerala [7]. The present study found that MPV accounted for 20 (32.8%) of 61 poisonous snake bites treated in the centre, a markedly higher proportion than the 1.7% reported in a larger cohort from North Kerala over four years [1]. This discrepancy could relate to differences in study duration, geographical focus, and referral patterns, with the tertiary centre possibly receiving more MPV bites from the Western Ghats region, where the species is endemic [11].

Fang marks were visible in 85% of cases, and local symptoms such as pain and swelling occurred in 65%, similar to Kumar KS et al., findings [1]. Local complications were rare; only one patient developed cellulitis, consistent with previous reports indicating low rates of tissue necrosis or severe local damage from MPV bites [1,3]. Interestingly, despite evidence of potent myotoxicity in-vitro due to metalloproteases and other venom components [12,13], the present study cohort showed no clinical signs of myotoxicity or extensive tissue destruction, suggesting possible geographical variation in venom composition or dose delivered [14]. Such venom variability has been described in other pit viper species as well, with important implications for clinical management and antivenom development [15].

Approximately, two-thirds of bites involved the upper extremities, most likely related to agricultural exposure, which is a known risk factor for snakebites in rural India [16]. The hand, being vulnerable with less protective soft tissue, is susceptible to venom-induced injury [7]. Prolongation of the 20-minute WBCT was seen in 40% of patients, although systemic bleeding was absent. This mild coagulopathy is consistent with MPV venom's action on coagulation factors via metalloproteases and serine proteases such as Malabarase [13,17]. In contrast, other viper species like *Daboia russelii* cause more severe systemic coagulopathy [5,18]. The lack of systemic bleeding and renal complications in the present study, compared to other reports [1], further supports the notion of regional venom variability.

About 75% of patients received polyvalent ASV, primarily due to prolonged WBCT or progressive local symptoms. However, the current Indian polyvalent ASV is formulated against the "Big Four" snakes and lacks proven efficacy against MPV venom [2,7,19]. Cross-reactivity studies using Enzyme Linked Immunosorbent Assay (ELISA) and Western blot have shown only partial neutralisation of MPV venom proteins by this ASV [8]. This likely explains the partial clinical responses observed and raises concerns about the routine use of polyvalent ASV in MPV bites, especially considering the risks of allergic reactions and the high cost of ASV [6,20]. The average ASV dose in the present study (approximately 10 vials) was lower than other studies [1,21,22], but without species-specific dosing guidelines, this comparison remains challenging.

The ASV administration carries risks, including mild urticaria and severe anaphylaxis, reported up to 40% in some series [6,23]. In the current study, only one patient had an adverse reaction, but rationalising ASV use remains critical to avoid unnecessary exposure and conserve resources. Emerging diagnostic tools like infrared thermal imaging show promise for differentiating venomous from non-venomous or dry bites at the point of care, potentially reducing unnecessary ASV administration [23-25]. Wider adoption of such affordable technologies could transform snakebite management in resource-limited settings.

Given the significant proportion of MPV bites in the Western Ghats and Wayanad region, increasing awareness among clinicians and the public about MPV identification and bite characteristics is essential. Preventive strategies such as the use of protective gloves during agricultural work could reduce incidence, especially since the majority of bites are on the hands [7]. Finally, developing region-specific and species-specific antivenoms tailored to MPV venom would be the ideal approach to improve treatment outcomes and minimise adverse effects [26].

Limitation(s)

The present study was limited by its relatively small sample size and single-centre design. Geographic variations in venom composition require larger multicentric studies to better characterise clinical syndromes and treatment responses. Furthermore, the lack of a control group and the use of polyvalent ASV without species-specific antidotes limit definitive conclusions on ASV efficacy in MPV bites.

CONCLUSION(S)

The MPV bites represent a considerable proportion of venomous snakebites in the Western Ghats, India, with most envenomations affecting the upper limbs. Clinically, these bites commonly present with localised pain, swelling, and mild coagulopathy, while systemic symptoms are relatively uncommon. Indian polyvalent ASV, formulated against the "Big Four" snakes, is frequently administered, but its efficacy against MPV venom remains unproven, raising concerns about its routine use. The administration of polyvalent ASV carries the risk of serious adverse reactions, including anaphylaxis, emphasising the need for cautious and evidence-based usage. To improve patient outcomes and optimise healthcare resources, there is an urgent requirement for the development of species-specific antivenoms for MPV, alongside the integration of novel diagnostic technologies, such as point-of-care infrared imaging or rapid venom detection assays, to guide targeted treatment.

Acknowledgement

The authors acknowledge Mr. Shivaprakash, manager of medical records department at Dr Moopens Medical College for assisting in electronic data retrieval that facilitated this research.

REFERENCES

[1] Kumar KS, Narayanan S, Udayabhaskaran V, Thulaseedharan NK. Clinical and epidemiologic profile and predictors of outcome of poisonous snake bites - an analysis of 1,500 cases from a tertiary care center in Malabar, North Kerala, India. Int J Gen Med. 2018;11:209-16.
[2] Menon JC, Sreekrishnan TP, Nair SB, Pillay VV, Kanungo S, Aravind MS, et al. Snakebite envenoming in India: It is time we look beyond the concept of the Big Four species. Trans R Soc Trop Med Hyg. 2025;119(9):1016-22.

[3] Lath V, Wagle U, Jabagodu Lingappa D, Ramya R, Katyal A, et al. Sentinels of the Western Ghats – envenoming by the Malabar pit viper (Craspedocephalus malabaricus) – a sub analysis of the VENOMS registry. Toxicon: X. 2025;27:100231.
[4] Gawas M, Rane S, Sawant N. A review of Malabar Pit Viper, Craspedocephalus malabaricus (Jerdon 1854), ecology from the Western Ghats of India and notes on feeding behavior. Reptiles & Amphibians. 2023;30(1):e18085.
[5] Harikrishnan M, Rohan KV, Ayyan SM. Trimeresurus malabaricus bites: Need of species-specific management for snakebites. J Emerg Trauma Shock. 2020;13(2):167.
[6] Vanuopadath M, Shaji SK, Raveendran D, Nair BG, Nair SS. Delineating the venom toxin arsenal of Malabar pit viper (Trimeresurus malabaricus) from the Western Ghats of India and evaluating its immunological cross-reactivity and in vitro cytotoxicity. Int J Biol Macromol. 2020;148:1029-45.
[7] Gopal G, Selvaraj H, Venkataramanan SK, Venkataraman S, Saravanan K, Bibina C, et al. Systematic review and meta analysis on the efficacy of Indian polyvalent antivenom against the Indian snakes of clinical significance. Arch Toxicol. 2024;98(2):375-93.
[8] Sirur FM, Lath V, ASC, Mohan G, Shastry S. A tropical kiss by a malabar pit viper. Wilderness Environ Med. 2022;33(1):116-21.
[9] Hijaz PT, Anil Kumar CR, Bins M John. A study on clinical and laboratory features of pit viper envenomation from Central Kerala, India. Int J Adv Med. 2018;5(3):644 51. Doi: 10.18203/2349 3933.ijam20182117.
[10] Khochare S, Senji Laxme RR, Jaikumar P, Kaur N, Attarde S, Martin G, Sunagar K. Fangs in the Ghats: Preclinical Insights into the Medical Importance of Pit Vipers from the Western Ghats. Int J Mol Sci. 2023 May 30;24(11):9516.
[11] Team Nature inFocus. India's striking variety of pit vipers. Nature inFocus [Internet]. [cited 2025 Oct 30]. Available from: https://www.natureinfocus.in/animals/india-s-striking-variety-of-pit-vipers.
[12] Gowda R, Rajaiah R, Angaswamy N, Krishna S, Sannanayak VB. Biochemical and pharmacological characterization of Trimersurus malabaricus snake venom. Toxicon. 2018;149:05-14.
[13] Gowda CDR, Rajesh R, Nataraju A, Dhananjaya BL, Raghupathi AR, Gowda TV, et al. Strong myotoxic activity of Trimeresurus malabaricus venom: Role of metalloproteases. Mol Cell Biochem. 2006;282(1-2):147-55.
[14] Warrell DA. Venomous bites and stings in South Asia. Curr Opin Infect Dis. 2020;33(5):462-68.
[15] Yong MY, Tan KY, Tan CH. A genus wide study on venom proteome variation and phospholipase A_2 inhibition in Asian lance headed pit vipers (genus: Trimeresurus). Comp Biochem Physiol C Toxicol Pharmacol. 2025;288:110077.
[16] Rathnayaka N, Kularatne SAM, Ranathunga PEAN. Coagulopathy and extensive local swelling following Green pit viper (Trimeresurus trigonocephalus) envenoming in Sri Lanka. Toxicon. 2017;129:95 99.
[17] Warrell DA. Snake bite. Lancet. 2010;375(9708):77-88.
[18] Chippaux JP. Snakebite envenomation turns again into a neglected tropical disease! J Venom Anim Toxins Incl Trop Dis. 2017;23:38.
[19] Gutiérrez JM, Williams D, Fan HW, Warrell DA. Snakebite envenoming from a global perspective: Towards an integrated approach. Toxicon. 2010;56(7):1223-35.
[20] Hooda R, Parameswaran N, Subramanian M. Serious adverse reactions to anti snake venom in children with snake envenomation: An under appreciated contributor to snakebite mortality? Indian J Crit Care Med. 2021;25(6):720 23.
[21] Menon JC, Joseph JK, Jose MP, Dhananjaya BL, Oommen OV. Clinical profile and laboratory parameters in 1051 victims of snakebite from a single centre in Kerala, South India. J Assoc Physicians India. 2016;64(8):22-29.
[22] Kavitha S, Nalini GK, Sahana GN. Evaluation of optimum dose of anti snake venom required and its outcome based on severity of envenomation in snakebite case. Asian J Med Sci. 2024;15(3):201 06.
[23] Sabitha P, Bammigatti C, Deepanjali S, Suryanarayana BS, Kadhiravan T. Point of care infrared thermal imaging for differentiating venomous snakebites from non venomous and dry bites. PLoS Negl Trop Dis. 2021;15(2):e0008580.
[24] de Silva HA, Ryan NM, de Silva HJ. Adverse reactions to snake antivenom, and their prevention and treatment. Br J Clin Pharmacol. 2016;81(3):446-52.
[25] Mohapatra B, Warrell DA, Suraweera W, Bhatia P, Dhingra N, Jha P, et al. Snakebite mortality in India: A nationally representative mortality survey. PLoS Negl Trop Dis. 2011;5(4):e1018.
[26] Abraham SV, Paul S, Mathew D, Rajeev PC, Paul MV, Davis C. Challenges in snakebite management in India: Insights from a physician survey with special focus on Kerala and treatment of bites by hump nosed pit vipers (Hypnale spp.). Toxicon Reg Rev. 2023;(Advance article). Doi: 10.1177/10806032241290800.

PARTICULARS OF CONTRIBUTORS:
1. Assistant Professor, Department of General Medicine, Dr. Moopen's Medical College, Wayanad, Kerala, India.
2. Assistant Professor, Department of General Medicine, Dr. Moopen's Medical College, Wayanad, Kerala, India.
3. Professor, Department of General Medicine, SRM Medical College Hospital and Research Centre, Chennai, Tamil Nadu, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Aneesh Basheer,
Professor, Department of General Medicine, SRM Medical College Hospital and Research Centre, SRMIST, Chennai, Tamil Nadu, India.
E-mail: basheeraneesh@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: May 16, 2025
- Manual Googling: Nov 25, 2025
- iThenticate Software: Nov 27, 2025 (1%)

ETYMOLOGY: Author Origin

EMENDATIONS: 7

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **May 14, 2025**
Date of Peer Review: **Sep 02, 2025**
Date of Acceptance: **Nov 29, 2025**
Date of Publishing: **May 01, 2026**